DU MONT

TYPE 405

VACUUM-TUBE VOLTMETER

405

Operating and Maintenance Manual

(Preliminary)

Allen B. Du Mont Laboratories, Inc.

TECHNICAL PRODUCTS DIVISION

760 BLOOMFIELD AVENUE, CLIFTON, N. J., U. S. A.

ADDENDUM

AFFECTING ALL INSTRUMENT INSTRUCTION MANUALS

The changes described below have been made to upgrade the performance and reliability of all Du Mont instruments which use 12AT7, 12AX7 or 12AU7 electron tubes.

Type	Du Mont Part Number	Replace With	Du Mont Part Number
*12AT7	2500 1530	ECC81/12AT7	2501 1690
*12AX7	2500 1500	ECC83/12AX7	2501 1680
*12AU7	2500 0130	ECC82/12AU7	2501 1610

* These tubes can be used as alternates.

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6703 2871

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ADDENDUM

AFFECTING INSTRUCTION MANUAL OF

Type 405 Vacuum-tube Voltmeter (Preliminary Manual #6703 3591)

The change described below was made to improve the 10 vac range calibration.

	Symbol	Du Mont Part Number	Description
Add	R138	0203 0750	Resistor, fixed, composition, 13K ohms, ±5%, 1/2 W
Delete	R138	0203 0480	Resistor, fixed, composition, 1000 ohms, ±5%, 1/2 W

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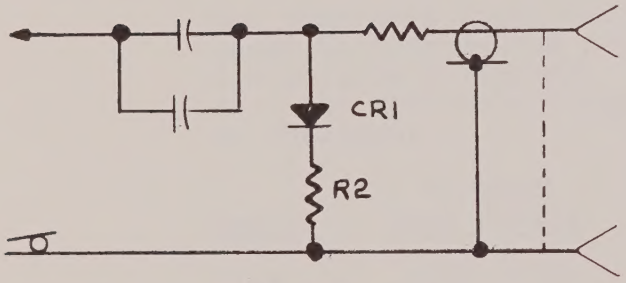
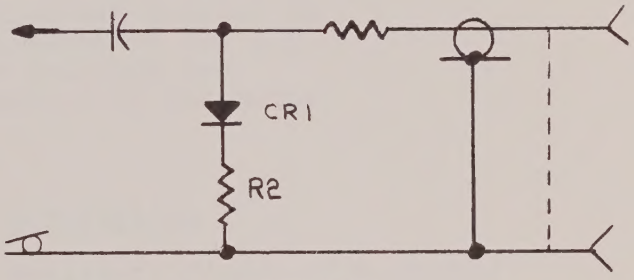
Type 405 Vacuum-tube Voltmeter (Manual #6703 3591)

On probes Type 2650 and 2651, a resistor R2 is added between the cathode of CR1 and ground.



TYPE 2651



TYPE 2650

Symbol	Du Mont Part Number	Description
R2	0226 0650	Resistor, fixed, composition, 100 ohms, ±10%, .1 W

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The component described below was deleted in order to improve the performance of the 405 Vacuum-tube Voltmeter. By deleting the resistor more even illumination of the meter is obtained.

Symbol	Du Mont Part Number	Description
R142	0210 0750	Resistor, fixed, wire wound, 2.7 ohms, ±10%, 1/2 W

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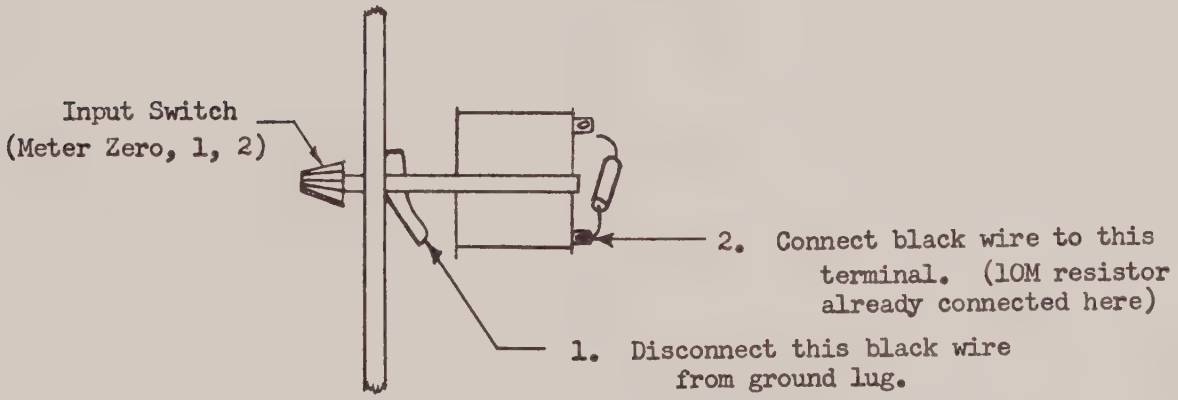
Type 405 Vacuum-tube Voltmeter
(Preliminary Manual #6703 3591)

The AC probe ground return connects to panel ground. Section 3.06 is not valid unless the instrument is removed from its case and modified as indicated in the sketch.


Input Switch
(Meter Zero, 1, 2)
2. Connect black wire to this terminal. (10M resistor already connected here)
1. Disconnect this black wire from ground lug.

Remember, when off-ground AC measurements are made, the two screws in the probe are at circuit ground. A potential exists between the exposed screws and panel ground.

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The replaceable lamp used for meter illumination is Du Mont Part Number 1200 9031.

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Type 405 Vacuum-tube Voltmeter
(Preliminary Manual #6703 3591)

In order to bring the Preliminary Manual for the 405 Vacuum-tube Voltmeter up to date, change the Du Mont Part Number of V102 from 2501 1600 to 2501 1610.

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AFFECTING INSTRUCTION MANUAL OF

Type 405 Vacuum-tube Voltmeter
(Preliminary Manual #6703 3591)

The changes described below were made to improve the accuracy of the 405 Voltmeter.

	Symbol	Du Mont Part Number	Description
Add	R122, R147, R148, R149	0203 1440	Resistor, fixed, composition, 10M ohms, ±5%, 1/2 W
Delete	R122	0224 4330	Resistor, fixed, film, 3M ohms, ±1%, 1/2 W
Delete	R146	0203 0650	Resistor, fixed, composition, 5.1K ohms, ±5%, 1/2 W
Add	R125	0203 1340	Resistor, fixed, composition, 3.9M ohms, ±5%, 1/2 W
Delete	R125	0223 7540	Resistor, fixed, film, 1M ohms, ±1%, 1/2 W

Schematic 98001401-4 changes as follows:

The connection between S103-3R (3) and the attenuator is changed from the junction of R105/R106 to the junction of R106/R107.

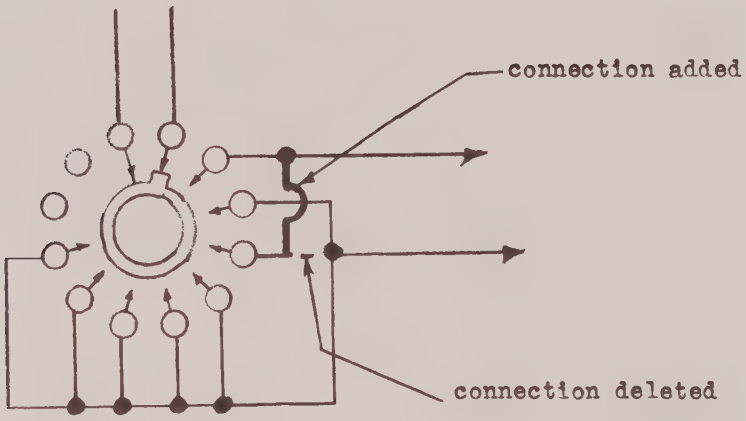
R147 is connected between S103-3R (100) and the junction of R108/R109.

R148 is connected between S103-3R (300) and the junction of R109/R111.

R149 is connected between S103-3R (1000) and the junction of R111/R112.

The position of R121 is changed. R122 connects directly to the arm of R118 and R121 is connected in series with the high potential side of R125.

The connections to S103-1F change as indicated below:



ADDENDUM

AFFECTING INSTRUCTION MANUAL OF

Type 405 Vacuum-tube Voltmeter
(Preliminary Manual #6703 3591)

The resistor described below is connected from the junction of R111/R112/R149 to ground.

Symbol	Du Mont Part Number	Description
R153	0203 1440	Resistor, fixed, composition, 10M ohms, ±5%, 1/2W

The Du Mont Part Number for Meter M101 changes from 2800 2191 to 2800 2192.

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ADDENDUM

AFFECTING INSTRUCTION MANUAL OF

Type 405 Vacuum-tube Voltmeter
(Preliminary Manual #6703 3591)

The changes described below were made to bring the preliminary Instruction Manual up to date.

Section 5.01

	Symbol	Du Mont Part Number	Description
Add	C114	0315 3750	Capacitor, fixed, ceramic, .005 uf, 500 V
Add	R122	0203 1340	Resistor, fixed, composition, 3.9M ohms, ±5%, 1/2 W
Delete	R122	0203 1440	Resistor, fixed, composition, 10M ohms, ±5%, 1/2 W
Delete	R125	0203 1340	Resistor, fixed, composition, 3.9M ohms, ±5%, 1/2 W
Add	R126, R128	0203 6810	Resistor, fixed, composition, 24K ohms, ±5%, 2 W
Delete	R126, R128	0222 5620	Resistor, fixed, film, 43K ohms, ±1%, 2 W
Add	R151	0203 1440	Resistor, fixed, composition, 10M ohms, ±5%, 1/2 W
Add	R152	0203 3710	Resistor, fixed, composition, 9.1K ohms, ±5%, 1 W
Add	V104, V105	2500 9020	Electron tube 0A2WA
Delete	V104, V105	2500 0300	Electron tube 0A2

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405 Vacuum-tube Voltmeter (Preliminary Manual #6703 3591)

The changes described below were made to bring Schematic 9800 1401-4 and the Electrical Parts List of Section 5.0 up-to-date.

Schematic 9800 1401-4

Change R138 from 13K to 15K

Change Note 9 to read: one of the following resistors might be added in parallel with R138 by the manufacturer to adjust 10 and 30 vac range R155, 120K; R156, 150K; R157, 200K; R158, 240K.

Change the Electrical Parts List as indicated.

	SYMBOL	DU MONT PART NUMBER	DESCRIPTION
		RESISTORS (fixed, composition, ±5%, 1/2 W)	
ADD	R138	0203 0760	15K ohms
DELETE	R138	0203 0750	13K ohms
ADD	R155	0203 0980	120K ohms
ADD	R156	0203 1000	150K ohms
ADD	R157	0203 1030	200K ohms
ADD	R158	0203 1050	240K ohms

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FIGURE 1. TYPE 405 VACUUM-TUBE VOLTMETER

1.0 SPECIFICATIONS

1.01 General

The Type 405 Vacuum-tube Voltmeter is a portable instrument designed to measure dc voltages from .1 volts full scale to 1000 volts full scale and ac voltages from .1 volts full scale to 300 volts full scale. It operates in the frequency range of 20 cps to 700 Mc using proper probes to cover most combinations of voltage and frequency. It will also measure resistance from .5 ohms to 500 megohms.

Scale calibration for the ac measurements is in terms of the rms value of a pure sine wave. On non-sinusoidal high-duty-cycle waveforms the instrument reads .707 of the positive peak.

A front-panel jack and switch are provided to facilitate dual-input performance on ac or dc. Circuit ground is isolated from chassis ground to facilitate differential or off ground input for dc measurements. The amplifier output is available from a jack at the rear. A meter zero position on the Dual Input Switch enables the user to adjust the zero control without shorting out the Input Probes.

The Type 405 is supplied with a captive dc probe and two of the following ac probes: UHF Probe Type 2650, Attenuator Probe Type 2652 and VHF Probe Type 2651. The third probe plus the following are available as accessories:

Type 2654	DC Probe
Type 2653	Probe Cable
Type 2656	Retractile Probe Housing
Type 2657	Coax. "T" Adapter

The instrument is also supplied with a kit containing:

1	Red test lead	2	Small test prods
1	Black test lead	4	Large test prods
2	Spade lugs	2	Banana plugs
2	Alligator clips		

All tips are adaptable to either the ac or dc probes or the leads.

1.02 Power Requirements

Voltage - 115 volts $\pm$ 10%

Frequency - 50 to 400 cps

Wattage - 40 watts

Fuse Protection - .5 amperes slow blow fuse

FIGURE 2. PROBE KIT

1.03	DC Operation	
	Volts full scale	.1, .3, 1, 3, 10, 30, 100, 300, 1000
	Accuracy	± 2% of full scale on all ranges
	Input resistance	121 megohms on all ranges
	Input capacitance	Approximately 2 uuf
	Drift	After 30 minutes warmup less than 3 millivolts during any four-hour period at constant ambient temperature and line voltage.
	Line voltage	Power line variations from 103 volts to 127 volts will not cause variation of the indicated voltage in excess of ± 5 millivolts after stabilization. Approximately 70% of this error can be corrected by resetting the Zero Adj. control.
1.04	AC Operation	
	Volts full scale	.1, .3, 1, 3, 10, 30, 100, 300
		The VHF and UHF probes are usable from .1 volt to 30 volts full scale. The Attenuator Probe is for use on the 100 and 300-volt ranges only.
	Input impedance	The ac input impedance is a function of both frequency and voltage level. At low frequencies the input capacitance is approximately 2 uuf for the VHF and UHF probes. The Attenuator Probe has an input resistance of 1 megohm with an input capacitance of approximately 2 uuf.
		Input impedances of the VHF and UHF probes at low frequencies, range from approximately 100,000 ohms at 0.1 volt input to above 1 megohm at higher levels.
	Accuracy	The calibration accuracy is ± 3% of full scale for sine waves subject to the frequency response (except for the Attenuator Probe which is ± 5%).

Frequency Response	VHF Probe - ± 1 db below 60 cps to above 200 Mc at .3 volt or higher. Down not more than 3 db at 50 cps at .1 volt.
	UHF Probe - ± 1 db 10 Kc to above 400 Mc rising to resonance above 700 Mc.
	Maximum High Frequency response requires use of the Type 2657 Tee Adaptor with the UHF or VHF Probes.
	Attenuator Probe - ± 1 db 50 cps to over 5 Mc. A trimmer adjustment, accessible through the probe body, enables the user to adjust the compensated attenuator to be accurate at even higher frequencies.
	The ac ranges have been calibrated for use with the VHF Probe if provided, otherwise the calibration has been made with the UHF Probe.
Drift	After 30 minutes warmup less than 3 millivolts during any four-hour period for voltages read on the linear ranges with the instrument operating at constant ambient temperature and line voltage. Drift on the non-linear ranges is proportionately greater.
Line voltage	Power line variations from 103 to 127 volts will not cause variation of the indicated voltage in excess of ± 5 millivolts after stabilization for voltages read on the linear ranges. Variation on the non-linear ranges is proportionately greater. Approximately 70% of this error can be corrected by resetting the Zero Adj. control.

1.05 Resistance Ranges

There are seven calibrated ranges from R X1 ohm to R X1 megohm. Calibrations on the meter scale are from .5 continuously to 500. Ohmmeter accuracy is ± 3% of reading when zero and infinity are properly set, limited by scale resolution.

The switch position after X1 megohm is wired (but not indicated on front panel) for X10 megohm and may be used. However, internal leakage resistance and grid current may limit the usefulness of the X10 megohm-range.

Maximum voltage at the ohmmeter input is .09 volts.

1.06 Mechanical Characteristics

All operating controls are located on the front panel. The meter movement is illuminated with mirror backing and knife edge pointer. All calibration controls, the fuse, and the output jack are accessible through a door at the rear of the instrument.

A compartment is provided at the bottom of the instrument to store the probes and the probe kit. Cable entry holes permit the compartment door to be closed while the probes are in use.

Height	-	10-1/2 inches
Width	-	7-1/4 inches
Depth	-	6-1/16 inches
Weight	-	12 pounds

2.0 CIRCUIT DESCRIPTION

The Type 405 Vacuum-tube Voltmeter consists of a precision attenuator, a dc amplifier, a cathode follower and a power supply as shown in the block diagram of Figure 3.

In operation as a voltmeter, a voltage at a high impedance is effectively transformed to a current at a low impedance. This current is used to drive the meter movement.

In operation as an ohmmeter, the resistance to be measured is effectively placed in parallel with a calibrated load across which a voltage has been applied. The change in voltage which occurs is applied to the input of the dc amplifier. The attenuator is the load.

The cathode coupled paraphase amplifier V101 develops a balanced output which is applied to the cathode follower V102.

A potentiometer, R118, adjusts the current of each section of V101 so that the amplifier can be balanced. A potentiometer R127 in the cathode of V102 functions in a similar manner.

Rheostats in series with the meter enable all ranges to be correctly calibrated.

Plate voltage for the dc amplifier and the cathode follower is developed in a full-wave rectifier connected to one secondary winding of power transformer T101. A capacitor input filter and two regulator tubes V104 and V105 maintain a constant output.

The other secondary winding of T101 is connected to the filament circuit. The filaments of V101 and V102 are connected in series with RT101 to regulate the filament current. A rheostat R143, in the filament circuit, is used to adjust the filament voltage to 5 volts. The winding is center tapped to provide 6.3 volts for the dial indicator lamps and the filament of V103.

An extra input connector is provided so that two probes can be simultaneously connected to the unit and two measurements can be compared without having to move a probe from one position to another. A switch on the front panel selects the input to be displayed on the meter.

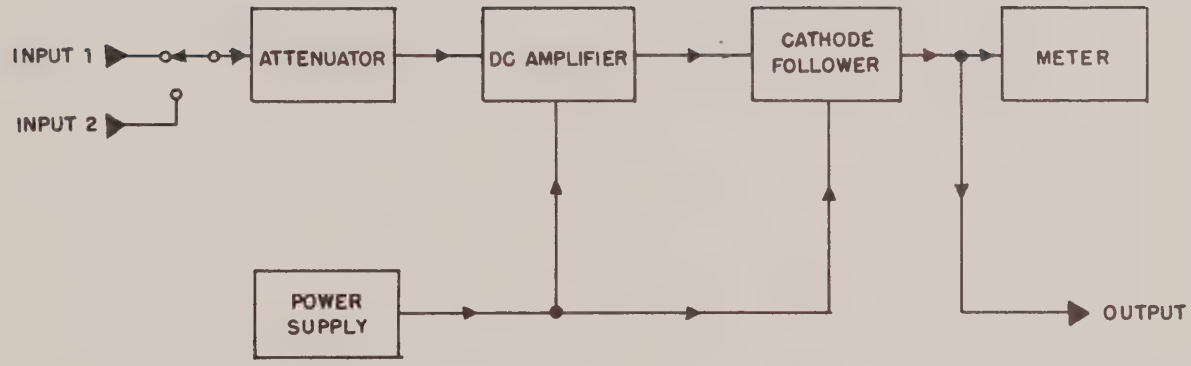


FIGURE 3. BLOCK DIAGRAM OF TYPE 405 VACUUM-TUBE VOLTMETER

Circuit ground is insulated from chassis ground and is brought out to a binding post on the front panel. Off ground ac or dc voltages can be measured between the proper probe and circuit ground with common mode voltages up to 1000 volts dc or 600 volts at 60 cps. Off ground measurements may be made at frequencies up to approximately 5 Kc before serious common mode errors are introduced.

An output jack is provided so that the instrument can be used as an impedance transformer or a power amplifier with a gain of more than two million. When the 405 is operated in this manner the meter is replaced by the load across the plug.

3.0 OPERATION

3.01 Control and Terminal Functions

1. Operating Controls

SELECTOR switch	-	Applies power to the unit and selects the quantity to be measured. When the switch is moved from the OFF position, the meter scale is illuminated and the Du Mont indicator lights.
RANGE switch	-	Selects the proper operating range.
ZERO ADJ potentiometer	-	Adjusts the meter pointer to 0 when the input is shorted to ground either by shorting the probe output to ground or by turning the INPUT switch to the meter zero position. The INPUT switch does not function in the OHMS position.
OHMS ADJ ∞ Rheostat	-	Adjusts the meter pointer for full-scale deflection when the SELECTOR switch is in the OHMS position and the OHMS input is open.
INPUT switch (Meter zero, 1 2)	-	Selects the desired input when two inputs are simultaneously connected to the instrument. The INPUT switch does not function in the OHMS position. In the spring loaded METER ZERO position, the inputs are disconnected and the instrument is shorted through a dummy load so that the ZERO ADJ control can be set without having to disturb the probes.

2. Terminals

PANEL binding post	-	Cabinet ground. A black lead is provided in the Kit to be used for ground connections.
CIRCUIT binding post	-	Circuit ground. A metal strap is provided connected to PANEL ground. When an off-ground measurement is to be made (ac or dc), the strap is removed and the measurement is made between the captive probe (Input 1) and circuit ground. Note that off-ground ac measurements may not be made to Input 2 since the ac return is always to panel ground at Input 2.
INPUT 2 BNC coaxial connector	-	Connects a second input to the unit for convenience in comparing two measurements. Used in conjunction with the INPUT one-two switch.
OHMS binding post	-	Input for resistance measurements. A red lead is provided in the Kit for input connection. Resistance measurement is made from the OHMS binding post to CIRCUIT ground.
OUTPUT jack at rear	-	When a standard three-conductor phone plug is inserted into the OUTPUT jack, the meter movement is disconnected and is replaced by the load connected across the plug.

3.02 General Instructions for Turning the 405 On

To turn the instrument on, connect the line cord to a source of 115 volts ac 50-400 cps, and rotate the SELECTOR switch to the +V or -V position.

Allow the instrument to warm up for ten minutes or more before being used to make measurements.

The power cable has three conductors. The round conductor is connected to the instrument panel ground. A two-terminal adaptor is provided for connecting receptacles which do not have a ground terminal

The instrument can be operated either standing upright on its four rubber feet or resting on the wrapup reel on its back.

3.03 DC Measurements

1. Place SELECTOR switch in the +V position to measure positive voltage or in the -V position to measure negative voltage.

2. Rotate the RANGE switch to the range which includes the voltage to be measured.

3. Short circuit the input to circuit ground with the dc probe, or switch to the METER ZERO position, and use the ZERO ADJ control to zero the meter.

4. Connect the dc probe and circuit ground across the circuit to be measured. A variety of probe tips are available in the Kit provided. Select the most appropriate tip for the measurement to be made.

3.04 AC Measurements

1. Place SELECTOR switch in ACV position.

2. Rotate RANGE switch to the range which includes the voltage to be measured.

3. Short circuit the input to circuit ground with the ac probe, or switch to the METER ZERO position, and use the ZERO ADJ control to zero the meter.

4. Connect the proper ac probe to the point in the circuit at which a measurement is to be made. The clip lead on the probe should be connected to the ground side of the circuit being measured.

   If desirable, at low frequencies the ground connection may be made directly to the CIRCUIT ground terminal.

At high frequencies the length and arrangement of the ground connection can affect the voltmeter reading since the probe resonant frequency is a function of the inductance in the ground loop. It is therefore necessary to keep the ground connection as short as possible. At frequencies above 100 Mc use of the Type 2657 Tee connector is recommended.

For voltages up to 30 volts rms the VHF or UHF probe should be used. For higher voltages, the Attenuator Probe must be used.

When the Attenuator Probe is used on the 100-volt range, the RANGE switch should be on the 10-volt range. Similarly, for the 300-volt range, the RANGE switch should be on the 30-volt range.

Whe changing probe types it may be necessary to recalibrate the ac range especially the more sensitive ones. The instrument has been calibrated for use with the VHF if supplied, otherwise it is calibrated for use with the UHF Probe.

CAUTION: Application of a negative dc step voltage or impulse in excess of 150 volts may damage the crystal in the UHF or VHF probes.

3.05 Resistance Measurements

1. Place SELECTOR switch in the OHMS position and rotate RANGE selector switch to the desired range.

2. Short circuit the ohms binding post to circuit ground and adjust the ZERO ADJ control for the meter to read zero. The red lead in the Kit is the ohmmeter lead and the black lead is the ground lead.

3. Unshort the input and adjust the OHMS ADJ∞ control to read infinity.

4. Connect the ohmmeter lead and ground lead across the circuit where a resistance measurement is to be made. The circuit to be measured should be de-energized prior to any resistance measurements.

3.06 Off-Ground Voltage Measurements

Circuit ground is isolated from chassis ground and is brought out to a binding post on the front panel. A link between circuit ground and chassis ground normally is in place. When off-ground voltages are to be measured, the link must be removed and the voltage measurement is made between the probe and the circuit ground.

The .01 capacitor from circuit ground to chassis ground can be unsoldered and the capacitance between grounds is approximately 500 uuf.

Common mode voltage may be as great at 1000 volts dc or 600 volts rms at 60 cps. Off-ground ac measurements may be made at frequencies up to approximately 5 Kc before serious common mode errors appear. When common mode voltage is high compared to the voltage to be measured, the instrument should be zeroed with the input probe and the circuit ground connected together and held at the common level.

Off-ground ac measurements may only be made using Input 1 since Input 2 (at the BNC panel connector) has its return permanently at panel ground.

When off-ground ac measurements are made, the two screws in the probe are at circuit ground. A potential exists between these exposed screws and panel ground.

3.07 Dual Input

The BNC jack on the panel labelled INPUT 2 is used in conjunction with the INPUT switch. It enables the user to measure voltage at more than one point in a circuit without having to disturb his probes.

To utilize this feature a cable such as the Du Mont Type 2653 must be connected to the jack and the probe to be used is then connected to the cable. All three ac probes and the dc probe with BNC connector are available as accessories for use at Input 2.

When both probes have been connected to the Voltmeter, the Input switch determines which probe is connected electrically into the circuit.

It is recommended that only probes of the same type be used for dual input operation in order to minimize errors that may exist between probe calibrations.

If maximum accuracy with ac probes is required, it is recommended that the calibration for both probes be checked prior to use in this manner. No such check is needed for dc probes.

The link between panel and circuit ground must be in place if dual input measurements are to be made.

The instrument will read erroneously if a dc probe is connected to INPUT 2 and the SELECTOR switch is in the ac position, and conversely.

Input 2 on the front panel enables the user to make up cables of any convenient length. In this way very long or short probe cables can be used without any modification of the instrument. Care must be taken that the cables do not introduce noise or leakage across the high impedance input circuit.

3.08 Using the Output Jack

A standard three-conductor phone plug mates with the OUTPUT jack on the rear of the Voltmeter. When plugged in, the meter movement is replaced by the load across the plug. When used in this manner as an amplifier (or impedance transformer) the Type 405 will deliver 1 ma output maximum into 100 ohms minimum. Maximum power gain is over 60 db. Output is obtained balanced around 60 volts.

The jack can be used to plug in a 1 ma mechanical recorder. Connecting the Type 405 and a recorder in this manner, the high input resistance, low drift and excellent stability of the 405 can be used to monitor slow voltage changes in high impedance circuits, single ended or off-ground.

If a high input resistance, voltage-sensitive type recorder is to be used, the jack can be bypassed and connection can be made across the bottom terminals of the two 43K 2-watt resistors R126 and R128 on the component board. The board is located on the right side of the instrument. In this manner the meter continues to operate normally while the recorder continuously records the voltage appearing at the output.

4.0 MAINTENANCE

4.01 General

The Type 405 Vacuum-tube Voltmeter has been properly adjusted at the factory and in normal operation will require a minimum of maintenance.

The case of the instrument can be removed for routine servicing by removing the two handle screws and the two screws on the bottom which fasten the case to the storage compartment.

The meter illuminating lamps can be reached by extracting the two screws on the front of the meter and removing the plastic meter cover.

With the instrument cover removed, most circuit voltages can be measured at the component board on the right side.

All adjustments are accessible behind the rear door of the instrument. Before removing V101 or V102 the instrument should be turned off. Since the heaters of these tubes are in the current regulator circuit, pulling out one will cause the voltage on the other to rise excessively.

4.02 Recalibration Procedure

When tubes or components have been changed, or when recalibration is desired in order to obtain maximum accuracy, the following procedure should be followed.

1. Warmup

   Allow the instrument to warm up at least 30 minutes with the cover on, the rear door closed, and at the line voltage and frequency of normal operation.

2. Set heater voltage

   Remove the cover. Adjust R143 marked FIL ADJ until the heater voltage is set to 5 volts. The heater voltage is measured at the terminal on the component board marked FIL.

   If the voltage can not be set, or if a change in line voltage of 10% causes the heater voltage to change more than 0.1 volt, replace RT101 (9-4D).

3. Check regulated voltages

These may be measured at the terminals on the component board marked +150 and -150.

4. Set up the amplifier

The INPUT switch should be turned to 1, the SELECTOR switch should be turned to + V and the RANGE switch to 0.1 volt full scale.

Remove the cover and connect the ground link.

A. Short V102A G1 to V102B G1 at the component board and adjust V102 BAL, inside rear door, until the meter reads zero. Remove the short.

B. Short the input of the DC probe to ground. Adjust ZERO ADJ on the front panel until the meter reads zero.

C. Disconnect the DC probe from ground. Adjust R121 marked IG inside rear door until the meter reads zero with open input. Monitor the cathode voltage of V102 at the lower terminal of the 43K 2-watt resistors on the component board. It should indicate approximately +60 volts when IG is properly set. If this voltage is changed significantly repeat steps A and B.

Readjust ZERO ADJ and IG as required until the meter reads zero under open or short circuit conditions. Replace the cover.

5. Set the ranges

A. DC

With the 405 set to measure 0.1 volt full scale, check that the ZERO ADJ is set properly. Apply 0.1 volts from an accurate dc voltage source. Adjust R133 marked 0.1 VDC behind the rear door until the meter reads full scale.

Repeat this procedure for 0.3 volt and 1.0 volt inputs adjusting R131 and R132 respectively.

B. AC

Using the UHF or VHF probe, set ZERO ADJ with the probe input shorted to ground. Set up the 405 to measure 0.1 volts ac.

Apply 0.1 volts ac from an accurate sinusoidal ac source at a frequency in mid-range (1 Kc to 100 Kc for VHF Probe, 100 Kc to 500 Kc for UHF probe).

Adjust R134 marked 0.1 VAC on rear for full scale accuracy.

Repeat the procedure for 0.3 volts, 1.0 volts and 3.0 volts adjusting R135, R136 and R137 respectively for full scale reading.

The instrument is now recalibrated.

4.03 Special Trouble Shooting Hints

1. Amplifier Maintenance

If the instrument can not be adjusted to read full scale with 0.1 volts on the 0.1 VDC range, if the linearity is very poor or if there is excessive grid current which is indicated by a high reading on the 0.1 volt range with the input open, check the setting of the IG adjustment.

By controlling the bias of the input amplifier, the IG control sets all the operating voltages for both amplifiers and adjusts the input bias for zero grid current.

Specially selected tubes are not required in the Type 405, however, a tube with exceptionally poor static or dynamic unbalance may result in improper gain or linearity. If adjustment of the IG control does not result in proper operating conditions, experiment by changing the ECC82/12AU7.

Rarely should the 6SU7GTy require replacement. If this tube does fail and a replacement is not immediately available, a 6SL7 may be used as a direct replacement with some loss in performance likely.

Occasionally, on the most sensitive range, application of voltage will cause the meter needle to overshoot and then drift slowly back to the proper setting. This condition does not affect the accuracy of the 405. In many instances, it will disappear as the 6SU7GTY tubes age.

If the IG setting has been changed, the recalibration procedure for setting up the amplifier and ranges should be repeated.

2. Probe Maintenance

Abuse of the probes, subjecting them to excessive voltage or temperature may result in damage and deterioration of diode performance. After extended life, the back resistance and the efficiency of the probe diodes will decrease. The diode should have a back resistance in excess of 1 megohm when 1.5 volts are across it.

If a probe appears to be defective, it should be checked as follows:

A. Remove the two fillister head screws and slide the sleeve off the probe body.

B. Inspect the components for damage or open connection.

C. Measure the back resistance of the diode (DR313).

D. If the diode must be replaced, use a low wattage soldering iron and exercise great care in soldering in the new diode. DO NOT OVERHEAT since heat can easily damage the diode or associated components.

E. Always recalibrate the ac range when a diode is replaced.

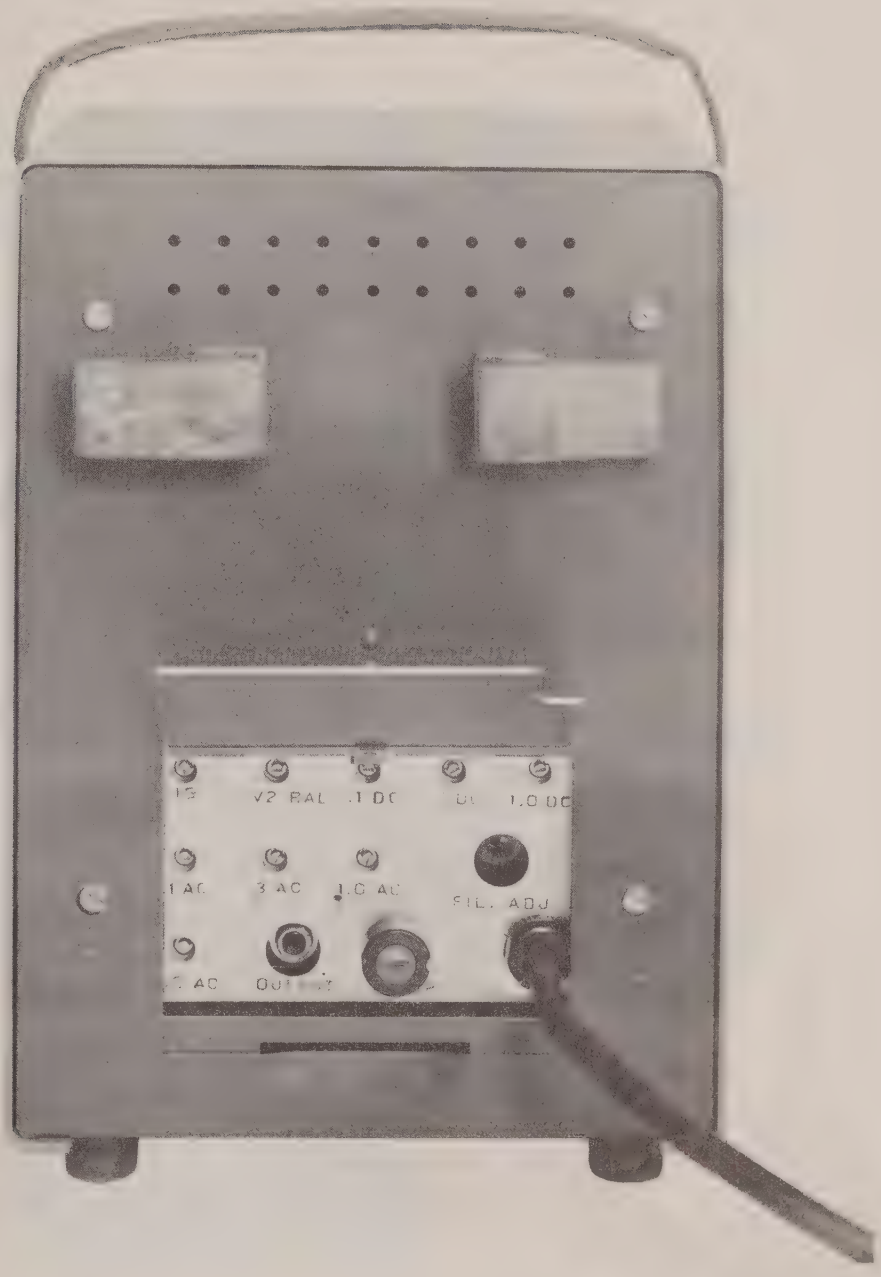


FIGURE 4. REAR VIEW

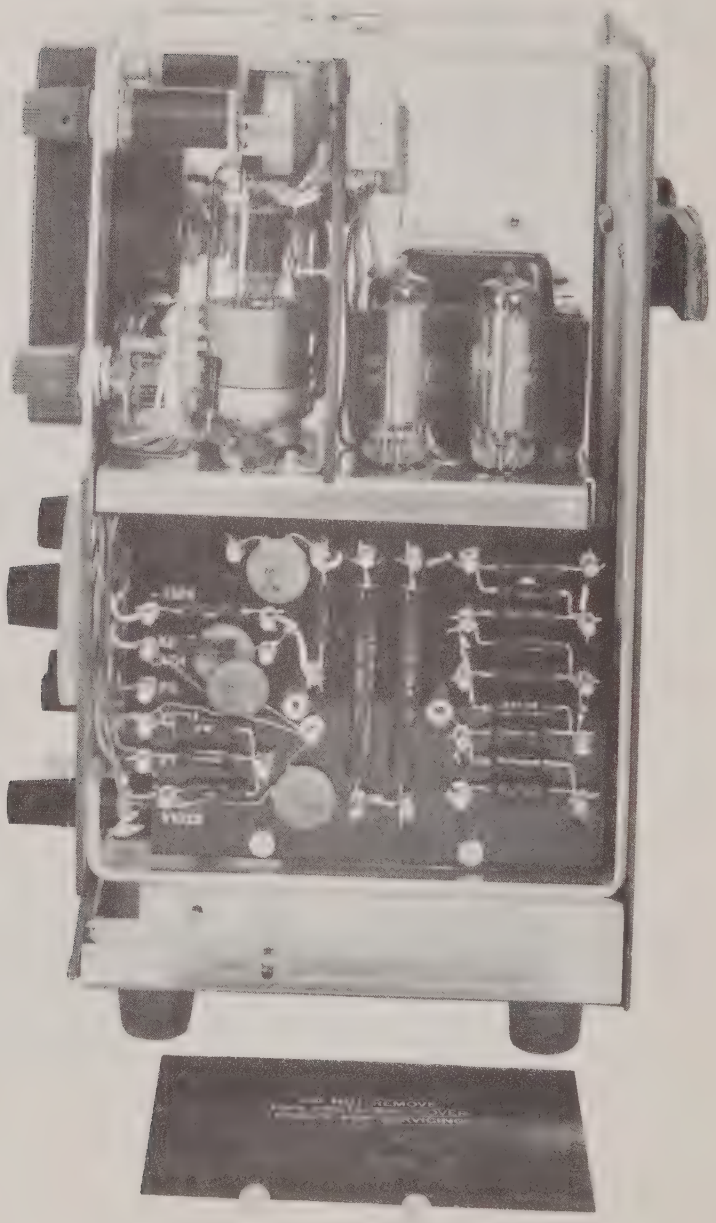


FIGURE 5. RIGHT SIDE VIEW

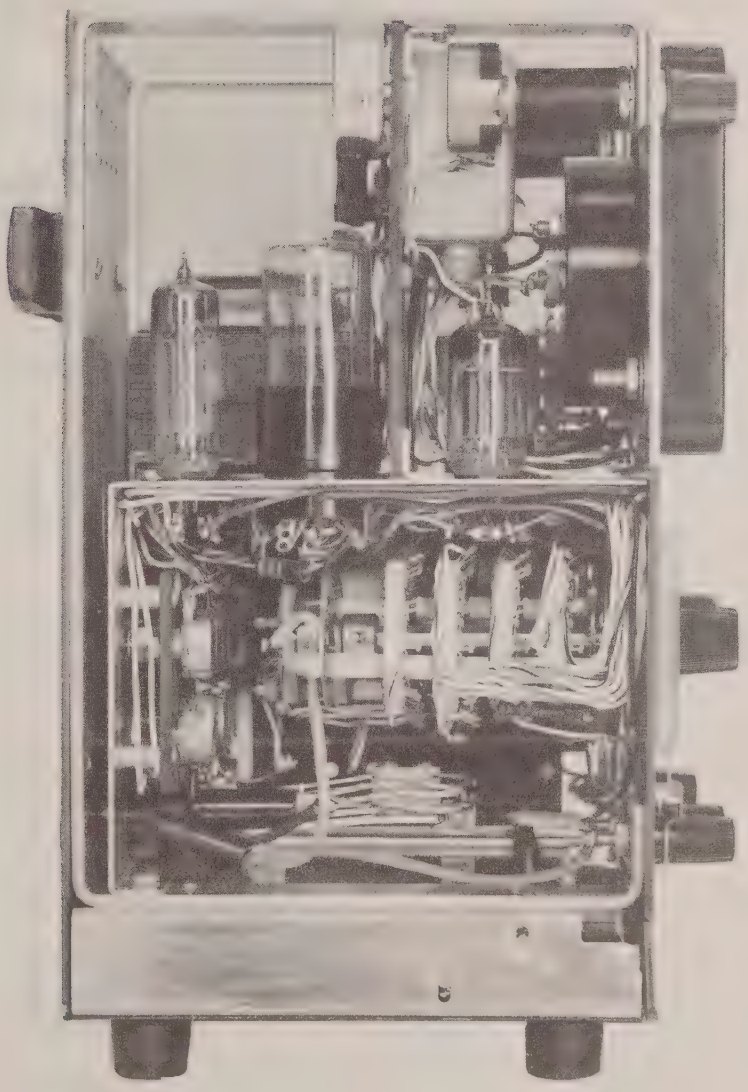


FIGURE 6. LEFT SIDE VIEW

5.0 ELECTRICAL PARTS LIST

5.01 Type 405 Vacuum-tube Voltmeter

Symbol	Du Mont Part Number	Description
	CAPACITORS	
C102	0313 4570	ceramic, 0.01 uf, +100 -0%, 1000 V
C103	0315 3750	ceramic, 0.005 uf, +100 -0%, 500 V
C104 to C107	0312 2700	ceramic, 0.01 uf, +100 -0%, 500 V
C108	0313 7620	paper, 2 uf, +20 -0%, 600 V
C109	0315 2010	ceramic, 150 uuf, ±20%, 500 V
C111 to C113	0315 2010	ceramic, 150 uuf, ±20%, 500 V
	FUSE	
F101	1100 0930	0.5 ampere, slow-blow
	LAMP	
I101	1200 1310	incandescent, miniature bayonet, 150 ma, 6.3 V
	RECEPTACLES	
J101	0902 9080	1 female contact, BNC Type UG-625/U
J102 to J104	5101 2551	post, binding, black
J105	0905 0390	jack, telephone
	METER	
M101	2800 2191	1 milliampere full scale, (No. 47 frosted lamps, I102 and I103 supplied as integral part of meter)
	CONNECTORS	
P102	0905 0750	1 male contact, BNC Type UG-88C/U
--	0905 0850	line-plug adapter, polarized, 15 amperes, 125 V
	RESISTORS (Resistance values in ohms; K= thousand, M= million. All resistors are fixed, film, ±1/2%, 1/2 W unless otherwise specified)	
R101 & R102	0203 1440	composition, 10M, +5%
R103	0203 6790	composition, 20K, ±5%, 2 W
R104	0239 0045	49.62M, 2 W

Symbol	Du Mont Part Number	Description
R105 & R106	0239 0044	25 19M, 1 W
R107	0239 0038	7.481M
R108	0239 0037	2.519M
R110	0239 0039	10M
R111	0239 0035	251.9K
R112	0239 0041	100K
R113	0239 0034	10K
R114	0239 0033	1K
R115	0239 0032	100
R116	0239 0031	100
R117	0223 7140	75K, ± 1%
R118	0107 4950	variable, wire wound, 5K, ± 10%, 2 W
R119	0223 7140	75K, ± 1%
R121	0107 1535	variable, composition, 2M, ± 1%
R123 & R124	0223 7650	2M, ± 1%
R125	0223 7540	1M, ± 1%
R126	0222 5620	43K, ± 1%, 2 W
R127	0107 1533	variable, composition, 10K, ± 20%
R128	0222 5620	43K, ± 1%, 1 W
R129	0107 4940	variable, wire wound, 500, ± 10%, 2 W
R131	0107 1533	variable, composition, 10K, ± 20%
R132	0107 1534	variable, composition, 50K, ± 20%
R133	0107 1532	variable, composition, 1K, ± 20%
R134	0107 1531	variable, composition, 500, ± 20%
R135	0107 1533	variable, composition, 10K, ± 20%
R136 & R137	0107 1534	variable, composition, 50K, ± 20%
R138	0223 6740	1K, ± 1%
R141	0211 2280	wire wound, 2500, ± 10%, 5 W
R142	0210 0750	wire wound, 2.7, ± 10%
R143	0102 3950	variable, wire wound, 7, ± 20%, 1.5 W
R144 & R145	0203 7560	18, ± 10%, 2 W
R146	0203 0650	composition, 5100 ohms, ± 5%
	REGULATOR	
RT101	0223 5290	current, Amperite 9-4D
	SWITCHES	
S101	0501 3261	rotary, 30, 1 section, 3 positions; spring-loaded fully CCW position; detents next two positions
S102	0501 4701	rotary, 30, 4 sections, 5 positions
S103	0501 4691	rotary, 30, 4 sections, 9 positions
	TRANSFORMER	
T101	2001 2251	power, 115 V, 50-400 cps

Symbol	Du Mont Part Number	Description
	TUBES	
V101	2501 1400	6SU7GTY
V102	2501 1600	ECC82/12AU7
V103	2500 0170	6X4
V104 & V105	2500 0300	OA2
	CABLES	
W501	5026 9641	assembly, power, electrical, 3-conductor, #18 AWG, 72 inches
--	5027 8240	rf, coaxial, noise free

5.02 Type 2650 UHF AC Probe

Symbol	Du Mont Part Number	Description
C1	0312 5720	capacitor, ceramic, 500 uuf, 500 V
CR1	2600 6080	crystal, DR313
R1	0239 0039	resistor, fixed, film, 10M, ±1/2%, 1/2 W
--	3303 3372	assembly: ground lead with alligator clip (3600 4670) attached
--	4201 3652	cover, test probe
--	3303 6912	housing, test probe; included as integral parts of this housing are the spring-loaded brass tip and the modified BNC Type UG-625/U female connector

5.03 Type 2651 VHF AC Probe

Symbol	Du Mont Part Number	Description
C1 & C2	0319 0871	capacitor, ceramic, 0.05 uuf, 500 V
CR1	2600 6080	crystal, DR313
---	3303 3372	assembly: ground lead with alligator clip (3600 4670) attached
---	5201 3651	cover, test probe
---	3303 6911	housing, test probe; included as integral parts of this housing are the spring-loaded brass tip and the modified BNC Type UG-625/U female connector

5.04 Type 2652 Attenuator Probe

Symbol	Du Mont Part Number	Description
C1	0315 2460	capacitor, composition, 0.68 uuf, ±20% 500 V
C2	0318 4110	capacitor, variable, ceramic, 3-12 uuf, 350 V
C3	0318 0100	capacitor, ceramic, sub miniature, 0.025 uf, 200 V
CR1	2600 6080	crystal, DR313
R1	0222 6340	resistor, fixed, film, 900 K, ±1%, 1 W
R2	0228 0250	resistor, fixed, film, 106K, ±1%, 1/8 W
R3	0239 0039	resistor, fixed, film, 10M, ±1/2%, 1/2 W
---	3703 3372	assembly: ground lead with alligator clip (3600 4670) attached
---	4201 3653	cover, test probe
---	3303 6913	housing, test probe; included as integral parts of this housing are the spring-loaded brass tip and the modified BNC Type UG-625/U female connector

5.05 Type 2653 Probe Cable

Description	Part Number
Assembly: consists of 3-foot length of cable (5027 8240) and connectors (0905 0750) attached at each end of cable	0904 1241
Cable, rf, coaxial, 1900 V rms maximum operating voltage, noise free	5027 8240
Connector, 1 male contact, BNC Type UG-88C/U	0905 0750

5.06 Type 2656 Retractile Probe Housing

Description	Part Number
Housing, retractile probe	5027 6651
Spring, compression	3004 8501
Stud, thread	6090 9841

5.07 Type 2657 Coaxial "T" Adapter

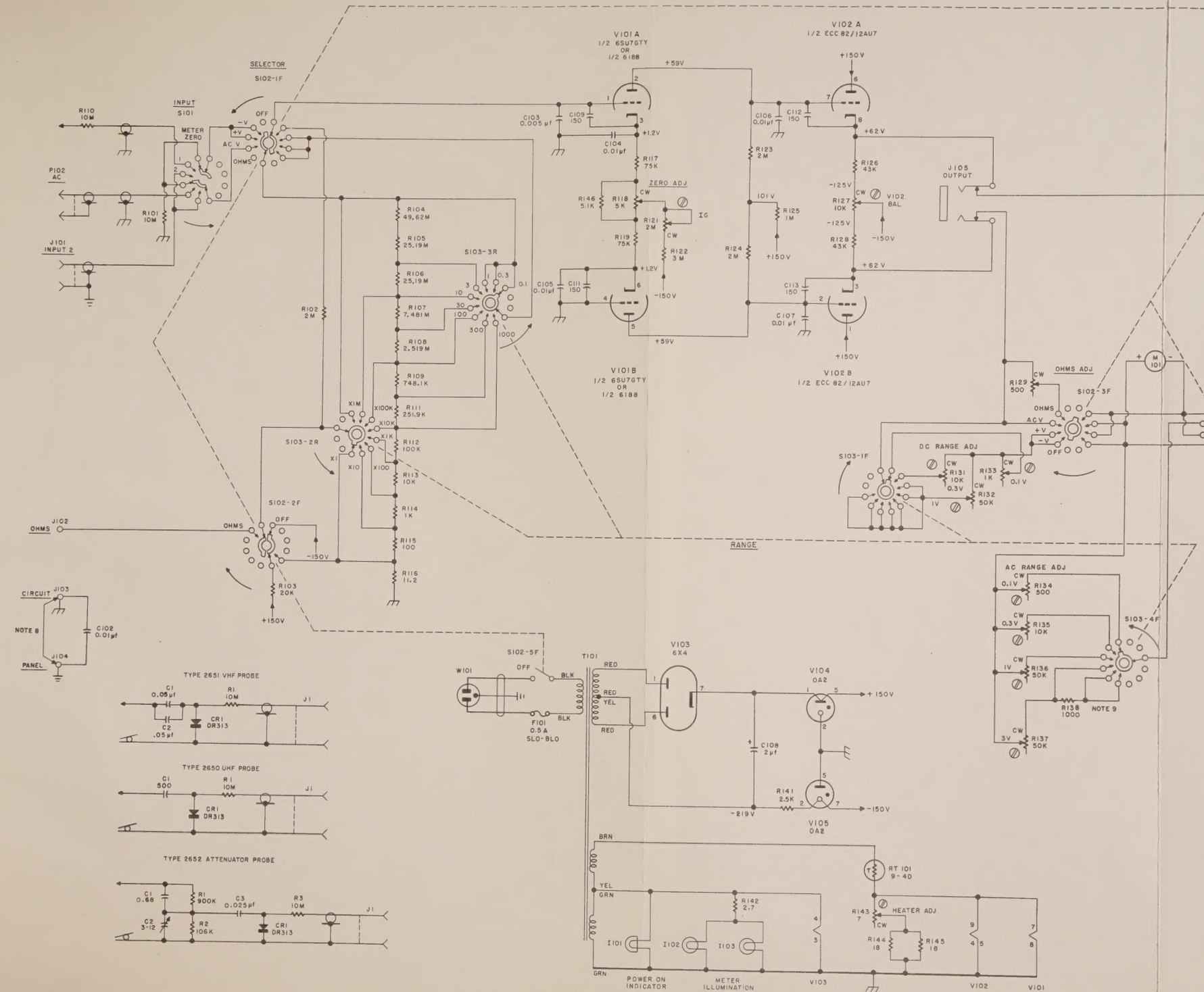
Description	Part Number
Adapter, coaxial T, modified Type "C" connector	0904 1272

5.08 Type 2663 Probe Tips and Leads Kit

Description	Part Number
Kit; contains the following:	5027 6711
a. test lead, red, 44" long, 1" and 4" red bakelite ends	
b. test lead, black, 44-1/2" long, 1" and 4" black bakelite ends	
c. spade lugs, 2	
d. alligator clips, 2	
e. test prod, small, needle nose, 2	
f. test prod, large, 4	
g. plug tips, banana type, 2	

5.09 Type 2654 DC Probe

Symbol	Du Mont Part Number	Description
R	0239 0039	Resistor, fixed, film, 10M ohms, ±1/2%, 1/2 W
--	3303 6911	Probe housing
--	4201 3651	Probe cover
--	6090 9081	Ground stud



NOTES:

1 - RESISTORS ARE IN OHMS; K= THOUSAND, M MILLION.
2 - CAPACITORS ARE IN µµf UNLESS OTHERWISE SPECIFIED.
3 - FRONT PANEL FACILITIES ARE UNDERLINED.
4 - ROTARY SWITCHES ARE SHOWN FULLY COUNTERCLOCKWISE; ARROW INDICATES CLOCKWISE ROTATION.
5 - ⏚ INDICATES CIRUIT GROUND WHICH IS ISOLATED FROM THE PANEL OR CABINET GROUND ⏚
6 - VOLTAGE READINGS MADE WITH A VACUUM TUBE VOLTMETER. THE INPUT OF THE TYPE 405 SHORTED TO GROUND, RANGE SWITCH (S103) ON .1 V RANGE AND SELECTOR SWITCH (S102) ON +V POSITION.
7 - Ø INDICATES SERVICE ADJUSTMENT.
8 - REMOVE LINK FOR OFF-GROUND OPERATION.
9 - NOMINAL VALUE SHOWN.
10 - INPUT SWITCH, S101, IS SPRING LOADED IN METER ZERO POSITION.

Figure 7. SCHEMATIC
DU MONT TYPE 405 VACUUM-TUBE VOLTMETER
(Reference Drawing 98001401-4, Issue 5)